Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

CONTRIBUTIONS TO THE LIFE HISTORIES OF PLANTS, NO. 9.

BY THOMAS MEEHAN.

Populus tremuloides.—A Monœcious case.

Noting on a young tree of *Populus tremuloides* on my grounds, which I had supposed to be a male, that a few of the catkins were still green when the most of them were faded, I was led to examine and found they were female. There were thirteen of these female catkins, and one hundred and fifty-one males. Seven of the pistillate aments had about one-third of the scales bearing stamens only, and about two-thirds with pistils only. Two were solidly pistillate with but a few stamen-bearing scales at the base. One had staminate scales for about one-third of its length from the base, the remaining two-thirds of the catkin being uniformly pistillate; while one was almost wholly male, there being but three female scales among the whole number. Two were purely pistillate, no trace of a staminate scale could be observed. The tree was seven years old, and growing freely, having made a growth of about three feet each year, for three years past. Some of these bisexual aments will be preserved in the herbarium of the Academy of Natural Sciences of Philadelphia. Bisexual scales were sought for but did not appear to exist.

Changes of sexual characters in diœcious plants are not uncommon, but have probably not been recorded before in connection with Salicaceous plants. The author has a large number of species of willow growing on his grounds. All these were subsequently examined carefully, but no similar case of sexual change was found among them.

Extra-Axillary Branching in Mertensia maritima.

Of this plant, as "*Steenhammera maritima* (R.[1])," Babington, in his "Manual of the British Flora," remarks that in habit, "it is sui-generis." I know of no attempt to explain the singularity. A study of the plant at Seal Harbor, Maine, on July 9th seemed to make its peculiarity clear.

---

[1] It may have been noted that in these biological papers, the name of the author of the species is seldom quoted. This omission is intentional though contrary to modern custom. In a treatise on systematic botany, such quotations are certainly in full place. But in public addresses or in everyday language, no one would think for a moment of repeating an author's name every time a plant was referred to, and there seems no reason why a scientific treatise when written in a conversational way, should not follow conversational rules.

It may first be noted that when a leaf starts from its parent stem we may look for a bud in the axis. If a leaf be present without an axillary bud, we conclude that there has been or ought to have been one, and look for some reason for the seemingly abnormal condition.

As already noted by the author, the common peduncle opposite to a leaf in Boraginaceous and other plants, means simply that the arrested axis has been pushed aside by the strongly developed growth of the axillary bud, which then assumes the leadership until "history repeats itself," and it also is pushed aside to make way for a new leader. But *Mertensia maritima* does not seem to follow this rule, and seems wholly exceptional. Everything proceeds for awhile in the usual way. The leaves are all alternate as a well-behaved Boraginaceous plant should be. But when in the flowering stage there are a pair of opposite leaves, and at the same node, three branches—one bearing flowers, and the other two continuing each an axial growth. How is it possible that three axial growths should have been developed from only a pair of leaves?

When these leaves are carefully examined, however, the axillary buds are found to be still there. They have not followed the Boraginaceous habit of pushing at once into growth, and, assuming leadership, pushing the parent shoot aside. The pair of leaves are not exactly opposite, and the branch bearing the flowers seems to occupy a space of its own on the stem, between the pair of leaves.

Dicotomous Branching in Spergularia media.

Noting that every flower was abundantly fertile, and suspecting from this fact self-fertilization, investigation followed and it was found that the pollen is shed just at the time of opening, thoroughly covering the stigmas, and absolutely insuring self-fertilization.

Comparing the inflorescence with some Boraginaceæ nearby, along the coast at Seal Harbor, an interesting lesson is taught as to how the dichotomous arrangement is produced from the opposite leaved, and the extra-axillary from the alternate leaved character, respectively. In *Spergularia media*, when the arrestation of axial growth occurs previous to the advent of the floral condition, the next pair of axillary buds start at once into growth and we thus have two actual centers of axillary growth, the arrested flower branch remaining in the dichotomous fork. In *Boraginaceæ* with its alternate leaved system, there is but a single bud to push into growth and become the main axis, which it does, pushing the arrested flowering branch wholly to one side, and which, in technical language becomes extra-axillary.

Missing Virticel in Glaux maritima.

Examining on July 14th at Seal Harbor some specimens of *Glaux maritima*, commenting on the well known and remarkable alternation of the stamens with the lobes of the calyx, a friend remarked that this arrangement would necessitate the lobes of the corolla being opposite the lobes of the calyx if the flowers had not been apetalous, which would be an anomaly in floral structure. But as the stamens in *Primulaceæ* are opposite the lobes of the corolla, we might naturally look for the same phenomenon in *Glaux* had the corolla been developed. Yet there is one point in this connection worth noting. In *Samolus* and some allied genera there are imperfect anthers in between the lobes of the corolla, and the opposite stamens are therefore easily accounted for when we understand that a series between them and the corolla has been suppressed. The position of the stamens alternate with the sepals in *Glaux*, again proves the existence of two series, as the suppression of both would bring the stamens just where they are between the lobes of the calyx. Another point is that the ease with which the outer series of stamens, united with the corolla in *Primulaceæ* generally, has been suppressed, causes no surprise when we see the corolla itself wholly suppressed in *Glaux*.

The tendency to suppression of parts and general irregularity is particularly striking in this genus. Though I examined many flowers of this plant on the north Pacific coast, I did not note any that were not 5-lobed and 5-stamened. Fully one-fourth of the flowers at Seal Harbor were tetramerous.

The irregularity of the leaves is well known—opposite until the flowering stage is reached, when they become alternate and frequently three-whorled.

Every flower is fertile; but all the flowers I could examine were expanded, and afforded no opportunity to observe the condition of affairs before opening.

Morphology is much aided by a study of the acceleration and arrestation of parts in erratic plants like these, and I regretted that my opportunities for further observations on this plant were so limited. It affords a promising field for others more fortunate.

THE RELATION BETWEEN RHYTHMIC GROWTH AND VARIETY IN CITRUS FRUITS.

The recognition that growth is rhythmic, and not one continuous act, affords a ready explanation of many phenomena otherwise inexplicable; and this is well illustrated by a comparison of various forms of fruit in the orange and other varieties of the citrus tribe.

Occasionally an orange may be found wholly formed inside of another orange, and more frequently an orange will be found projecting from the apex of another—that is, but partially enclosed—while in another which has been propagated as a distinct variety and called the Navel orange, a very small attempt to form another fruit at the apex is generally seen giving the navel or umbilical appearance from which the variety derives its name.

The morphological unity of the foliaceous and floral parts of a plant being conceded, we conceive of the axis as being arrested in its longitudinal development when a flower is being formed. In most oranges we find the axis still extending a considerable distance into the fruit, but varying very much in consistency in different varieties. Sometimes it is quite woody, in others it is found cellular and so soft that it can be compressed between finger and thumb; while in some—notably in a variety known as the Tangerine—there is rarely but a few lines of axis, usually no axis at all.

The rhythmic waves of growth are not all of equal measure. As in jumping a ditch, a boy may now rest exactly where he lands, and now have to continue several paces before final rest, so does the wave force in growth vary in intensity. In the process of the metamorphosis of a branch with its various nodes into a flower and finally a fruit, the expenditure of force in the arrestation of axial growth and the development of the appendages to petals, stamens and carpels is exactly meted to the results—now it is short of the mark, and the axis starts under another rhythmic movement the next time to be arrested for good and all.

It is this succession of growth rhythms that produces the double fruit oranges, but the phenomenon is not confined to the citrus tribe. In the formation of cones in the coniferous family the branch in its axial growth is usually wholly suppressed; but occasionally, especially in the Larch where the tree is young and in a very vigorous condition, the growth-wave not being wholly exhausted, will make another venture, and a weak shoot from the apex of the cone results. In Rosaceæ the same phenomena are by no means uncommon. One rose blossom will push out from the center of another, and a small branch bearing a miniature pear has been known to spring from the crown of a pear of normal character beneath it.

The main purpose of this paper is to note the remarkable origin of the variety of orange known as the Tangerine, and this by reason of a singular variation in the character of the force in the rhythmic wave. In the primary wave, for some reason yet obscure, it is remarkably weak, and sends the greater part of its effort into the secondary one. What is usually the small orange within the larger in the double orange, or the minute orange in the apex of the navel variety, becomes the leading and only original fruit!

Once in a while nature furnishes the absolute proof of this morphological conception. It is not rare to have specimens of Tangerines in which are from five to ten abortive carpels at the base of the fruit. In these cases the well defined axis, usual in the common orange, runs through the lower abortion, to be suddenly and finally suppressed when the upper cycle of organs takes its turn to become fruit. The Tangerine has always a flattish or oblate form. The utter suppression of the axis at the point of its formation naturally favoring a lateral growth.

The key herewith furnished, will doubtless disclose to us the secret of the many forms which the citrus tribe often assumes. The length of the lemon as compared with the more globular orange is evidently due to a more rapid advance of the growth wave. This naturally leads to a more elongated form. This hypothesis is supported by examining a half section of the lemon taken longitudinally. The axis is much more apparent and more woody than in the orange. It will be found to have come to a rest at the apex of the oval, starting again as from a regular node on the branch, to form a new and weak axis through the nipple which forms such a distinguishing mark of the lemon as compared with the orange. The nipple is possibly the result of the secondary rhythmic growth, which in the Tangerine orange was able to advance to a perfect fruit. From the limited opportunities of examining large quantities of lemons from seedling trees, I have not been able to demonstrate this as an actual fact as in the case of the orange, but I feel sure some one may meet with an abnormal specimen which will prove the point.

The varying intensity of rhythmic waves of growth may come to be regarded as a leading factor in the development of form. These waves certainly have to do with the varying sexual characters of trees, as I have shown in other papers. The fact brings us near to a certain knowledge of the origin of form, though we have still to learn what causes the variations in the intensity of these waves. Even in these different forms of citrus fruits the varying forces affect fertility. In the case of the Tangerine orange, in which the secondary rhythm has been accelerated to such an extent as to cause abortion in the whole of the lower carpellary system, the seeds necessarily are not formed. In the case of the Navel, where the secondary wave has only drawn part of the force from the lower, it usually results in so much weakening of the latter's power that few or no seeds result. The Navel is usually a seedless fruit.

MORPHOLOGY OF THE STIPULE IN COMARUM PALUSTRE.

I have claimed that when axial growth is arrested to form the inflorescence, a suppression of leaf-blade, and a corresponding development of stipule or dilated petiole usually occurs in the morphological conception of a flower. In other words, instead of petals and sepals being metamorphosed leaves, they are more critically metamorphosed stipules.

This is well illustrated in *Comarum palustre.* Examining a branch we find only a stipule at the lowermost node. Ultimately a leaf with two pairs of leaflets and one odd one. Then growth becomes suppressed as the flowering stage approaches. The next node has the leaf trifoliate, the next with only a single terminal leaflet, the next with the stipule only. It is seen that all the next nodes have stipules only and the sepals are but stipules. I have before noted that *Rosaceæ* afford the best illustration of the fact that petals are but enlarged and modified stipules, and not transformed " leaves " as generally understood.

FERTILIZATION OF MALVA ROTUNDIFOLIA.

Prof. Herman Mueller, in his work on cross-fertilization of flowers, indicates that *Malva rotundifolia* invariably fertilizes itself in case insects should not visit the flower in its earliest stages. Unless, as I think may be the case, flowers behave differently in one stage of growth, or at one season, from another, I must conclude that it is fertilized before expansion, and that insects in no way assist the operation.

Early in October I noticed a plant, five feet in diameter, that had evidently been blooming for months previously. It had many hundreds of capsules, and there were no indications that a single flower had failed to be fertile. With my own proposition before me that perfect fertility indicates close fertilization, I was led to place the plant under close observation many times a day for a week.

During all this time I did not notice a single insect visitor. Watching the plant a few times by night, no nocturnal visitors were seen. At seasons more pregnant with insect life the plant would no doubt be visited, for no flower is slighted in case of necessity by honey or pollen gatherers. There were none at this time, but the seeding was still going on, and continued till the first severe frost in December. It can be surely stated as a matter of fact, that there were no insect visitors during the last half of the season, and yet the plant was abundantly and unfailingly fertile.

An interesting result of my close observation was the discovery of three great periods of rest and of growth-resumption during anthesis. In the early morning of one day is seen the folded pink corolla in the position of a small cone peeping through the green calyx. Commencing watch at this stage, growth progresses till about noon, when there is a rest till the next morning; again there would be the same period of advance to rest, and the third day again an advance, followed by the withering of the floral organs.

Returning to the first period, the unopened bud, dissected at 8 A. M., showed no indications of pollen having been discharged. By 10 A. M., the flowers were still tightly closed, but the anther sacs had become ruptured, and the pretty purple styles, nestling in the center of the mass of stamens, were completely covered by pollen. By 11 A. M., the corolla had so far untwisted that a slight glance of the stamens and styles could be had in some flowers. By 12, noon, the corolla had taken on a narrow campanulate form, as wide at the bottom as at the top. By 1 P. M., it had again closed, so that the flower was expanded but about an hour only during the whole period of its existence. If it were desirable, therefore, for any insect to aid it in fertilization it would have but an hour at noon in which to work; but as we have already seen, the pollen had reached the stigmas a short time before.

From this time until near noon the next day, everything seems absolutely at rest; but at 11 A. M., the corolla again expands so as to be widely campanulate, and the pistils are found advancing beyond the line of the anther cells, carrying along with them the comparatively large pollen grains that had been deposited the day before. By 1 P. M., the corolla has again closed, drawing up and closely pressing the pistils and the anther cells together. It is at this period of the observations that the most beautiful phenomenon of the whole may be observed. Along the inner face of the style from apex to base is a single line of minute hairs. The pollen grains attach themselves to these hairs and are thus arranged in a single line like bright pearls along a curved silken thread. Dr. Ida A. Keller, who has kindly repeated some of the observations I here record, finds indications of pollen tubes entering the pistils through the papillæ or hairs.

On the third day, toward noon, though the petals remain closed, the pistils will be found withering, and the carpels enlarging, thus indicating that fertilization has been accomplished.

In the Proceedings of the Academy, 1889, page 55, in a paper entitled "On Secund Inflorescence," I have shown that in a number of flowers with a convolute æstivation, the spiral line in closing is directly the reverse of that followed in the opening. A surprising fact was noted in connection with this *Malva* that in closing, the twist might be either from left to right or right to left—both lines existing on the same plant. All attempts to form an hypothesis accounting for this remarkable behavior failed.

One fact strongly developed by these observations is that fertilization may be accomplished before the pistils have completed their growth, thus confirming the observation of Dr. Ida A. Keller in her paper on *Monarda fistulosa* in the Proceedings of the Academy, 1892, p. 452.

THE PEDUNCLE IN STREPTOPUS AMPLEXIFOLIUS.

The point I have strongly presented in connection with "extra-axillary" branches, that these are but arrested leaders which have been supplanted in leadership by the strong growth of the axillary bud, is remarkably well illustrated in *Streptopus amplexifolius*. Dr. Asa Gray says of it "it has small (extra) axillary flowers, either solitary or in pairs, on slender thread-like peduncles, which are abruptly bent or contorted near the middle." And further, "the peduncles, as in the next, are opposite the leaves, rather than truly axillary, and are bent round the clasping base beneath them." From what I have already recorded there will be no difficulty in perceiving that the "peduncle" is but a depauperate and displaced central axis, but the great disparity in the strength of the displaced and succeeding axes is very remarkable. The peduncle itself goes through the same metamorphosis. It is an arrested branch, and at the point where it is "abruptly bent or contorted near the middle," there would, under more vigorous vegetative conditions, be a node.

With a good lens we can see a minute bract, with an axillary bud, which latter seems now to terminate the straight or lower portion of the peduncle, and which bud in its development seems to have pressed or bent over the original axis, which has become a pedicel bearing the flower.

The peduncle, by a peculiar twist, turns around the stem, and gives the appearance of being axillary instead of truly "extra" axillary. This arises from the plant being an incipient twiner; some of its allies having actually achieved this habit. The midrib of the leaf curves more than 30° from a straight line, showing the strong convolutionary character of the plant.

During my short stay at Seal Harbor I had no opportunity to observe as closely as desirable; but it seems certain that the ovarium, though three-celled, has its walls made up of six original leaves. The series of three outer leaves have become so thoroughly blended with the three inner ones, that no one would suspect their existence, except by watching the young fruit through the several stages of ripening. The three outer ones color before the three inner ones. At this stage their outlines are distinctly seen. At this time, also, there is a slight tendency to a hexagonal form, which has been noted in *Trillium*, though the hexapetal character seems not to have been suggested.

THE ANTHESIS OF BRUNELLA VULGARIS.

Little new could be expected from a plant so common as *Brunella vulgaris*, but noting at Seal Harbor, on July 18th, that every flower was fertile, close fertilization was suspected.

Pulling off at night-fall all expanded flowers, it was found the next morning that all the flowers to expand that day were open before 8 A. M. There is a total rest after this till a little before 8 A. M., the next morning. Opening a flower before its normal time it was found that the anther cells were already ruptured, and one—

the lower lobe of the forked style—pressed into it, and covered with pollen. A number of flowers were opened, all exhibiting the same phenomenon. The branched filament, as is well known, bears an anther cell on one fork only. At the time above noted the arms diverge in nearly opposite directions; but eventually the barren one becomes nearly erect, which has led some authors to describe the stamen bearing the anther on a lateral horn-like process.

The opening of the flowers is the work of the lower lip alone. In the unexpanded bud it extends inward and under the upper lip, and falls over, seeming to clasp the anthers. When the opening time arrives this lower lip is withdrawn till it presents a right angle with the upper lip, and finally falling back till it reaches the tube of the corolla. Soon after mid-day the style branches close—an indication that fertilization has been accomplished. The style, however, continues to lengthen. The corolla only continues about 24 hours, as early the day following they drop out of the calyx tube.

A small species of bumble-bee, rather numerous, paid constant visits to the flowers. Hypothetically one might reasonably regard the flower as arranged for cross-fertilization by insect agency. The branches of the style seem favorably situated to receive pollen from the back of an insect visitor. As a matter of fact, however, none of these visiting bees were seen touching the style branches in any way, though I watched them closely for a long time. As the lobes close at noon, there could be no benefit if they did touch them after that. Insect aid could be given between 8 A. M., and noon. If in any other part of the world they are of service they must be larger than these bees were; but as the flower certainly fertilizes before opening at this season, in this place, it is not conceivable that the hypothetical arrangements are theoretically correct.

The head of flowers is a contracted spike, and is composed of numerous verticils in which there are three flowers to each axil. The central flower of these three is always the first to open, and hence the anthesis is centripital. Though this would thus seem to be the general plan, strange to say, the first flower to bloom on a head may be from any part—either near the apex or near the base. They appear from any part without any regard to order or system. No explanation of this disorderly blooming seemed satisfactory.

It has been a point with the author of these "Contributions" that a leaf does not originate at the node from which it seems to spring, but at some indefinite point on the axis below. In *Brunella* the edges of the leaves are ciliate. The stems are bifariously hirsute. No explanation of this seems to the author reasonable but that this results from the meeting of the cilia on the edges of the narrow bases of the foliar organs, and which, at the node above, expanded into a laminal condition—a leaf blade.

BRANCHING OF EUPHORBIA HYPERICIFOLIA AND E. MACULATA.

There are some peculiarities in the branching of these two species of *Euphorbia* difficult of explanation in each case, but very clear when studied in comparison with each other. As a general principle in plants we look for an axillary bud at the base of every leaf, or we can usually conceive some reason why the axillary bud has not been developed. Taking a branch of *Euphorbia hypericifolia* we find the leaves opposite, but one somewhat stronger than the other. The main stems are somewhat flexuose. On the one side of the main shoot an axillary bud has developed from the base of the leaf into a weak lateral branch, but there seems to be no trace of an axillary bud at the base of the leaf opposite. We ask, what has become of the bud which should have been at the base of that leaf?

In *E. maculata* the branches are not flexuose. A straight stem proceeds from the main branch, having many pairs of leaves at the nodes. At the base of one of the leaves there is an axillary bud, no bud at the base of the leaf opposite, which seems very closely attached to the straight central axis or main stem.

Returning to *E. hypericifolia* we find, toward the end of the season's branch, a very weak peduncle between the forks of the branches, having at the apex a head of flowers. We now see that this pedicel was the original main stem, and that what we have before taken for main stems were the products of axillary buds in cases where the main axes were wholly suppressed. With this total suppression came the effort on the part of one of the axillary branches to supply the loss, and this is the one which has given the impression that the subtending leaf had no axillary bud. There was a bud, and that bud pushed so strongly as to become a substitute for the suppressed central stem. The weaker bud, axillary to the weaker leaf, either continues as a bud or pushes into a weaker axillary growth. It is, however, of sufficient strength to compete somewhat with the opposite stem growth, which cannot, therefore, become perfectly straight, and the result is, as we see, a necessarily flexuose habit.

Now reverting to *E. maculata* we find a much greater disparity in the size of the opposite leaves, and necessarily in the size of the strength of the axillary bud. The large leaf, which seems to have no axillary bud has really had one so strong in proportion to the leaf opposite that it has pushed it wholly aside, has succeeded in forming a perfectly straight stem. The straight stem in *Euphorbia maculata,* is really made up, therefore, of an axillary branch which at each node has wholly taken the place of the main axis which has become totally suppressed at each point.

As, however, the vegetative growth becomes more under the control of the reproductive force, the vigor of the side branches which proceed from the axillary buds along the main stem is checked ; and with this the axial growth develops sufficiently to form a peduncle and flower-head as already noted, and these central axes bearing the flowers get stronger and stronger, just in proportion to the development of reproductive agencies.

We are taught by these illustrations the great lesson that the power of an axillary bud to draw to itself nutrition at the expense of the main axis and opposite axillary bud is the chief cause of the varying characteristics of the branches. In the same plant it causes a variation from a merely flexuose stem in the lower portion to an almost perfectly forked condition finally—while it equally accounts for a wholly different character of straight main stems in an allied species.

The exact manner in which an axillary bud can achieve such a power of nutrition as to entirely obliterate and supplant the main axis, and how again that main axis can still again overthrow its lateral competitor and advance sufficiently to become a flower-bearing peduncle is yet a grave question which cannot be answered. But a consideration of all the facts brings out the safe conclusion that the achievement of greater power in some buds to advance over others by drawing to themselves nutrition at their expense is a powerful factor in the origin of form.

As every flower head produces seed, it is safe to assume on my theory that the flowers self-pollinate. An examination shows that this is the case. Long before the involucre unfolds the staminate flowers have scattered their pollen over the pistils of the female flower, thoroughly dusting them. The glands are generously nectariferous, larger and more productive of fluid in *E. maculata* than in *E. hypericifolia.* All effort to form a conception of the function of this honeyed secretion has utterly failed. At no time have I ever seen a solitary insect visit these flowers. The beauty of the involucre can only be seen by a strong lens. While the nectariferous glands are larger in *E. maculata*, *E. hypericifolia* has the larger and the prettier involucre. The observations were made during September and October in Germantown.

Dimorphic Forms of Lythrum Salicaria.

An extended notice of the several forms of flower in *Lythrum Salicaria* occurs in Mr. Darwin's "Forms of Flowers," pp. 137–248.

My observations and deductions vary somewhat from those of this eminent naturalist. I have noticed in my own general investigations that the behavior of plants is not always uniform at all times and seasons. It is best to say that my investigations extended over the four days of July 30, 31, and August 1, 2. The first three days examination refers to a plant in my own garden—the last day to wild plants half a mile away from my garden plant.

The plant at this date had been in bloom for probably a month, but the upper portion of the central spike, and the upper portions of the lateral branchlets, were still growing and blooming freely. The first observation was that the lower half of the central spike was barren and the upper portion was seeding, but indifferently. The lateral branchlets had every flower fertile. I set myself to discover the reason for this difference. I found the flowers to be all of what Mr. Darwin called his long-styled kind. Mr. Darwin found the long-styled kind fertile though growing by itself. The point is confirmed in this case, and yet there remained to be disclosed why so many of the earlier flowers were infertile. In a three days' close watching of this plant I found no insect visitors except one Lepidopter.

This seemed fond of the flowers, and numerous individuals of the species were in constant attendance. I could not satisfy myself, however, that the stigma was ever touched by it, and I suspected some arrangement in the bud for self-fertilization. The style pushes through the bud before the corollas expand and the glutinous stigma is in receptive condition. On opening an unexpanded bud from which a style had thus protruded, it was found that none of the anther cells had become ruptured. Neither Mr. Darwin nor anyone appears to have opened an unexpanded bud. The disposition of the style in this condition is one of much interest. The upper portion represents two coils of a spiral, and the whole pistil resembles in miniature a ramrod when in use cleaning a gun. As soon as the stigma emerges from the closed corolla, the coil straightens out in a very short time.

The flower seems to have taken a rest at this stage in all its departments. At 9 A. M., the next day, an unopened bud of the same age as the former, had still not ruptured the pollen sacs. It was the same at 10, 11, and again at 12, noon. The unbroken anthers on the short stamens, were double the size of these on the longer stamens, in this respect differing from the observations of Mr. Darwin. At 2 P. M., the anther cells of the lower stamens were polliniferous: up to 6.30 P. M. the upper anther cells were entire. At 8 A. M., of Aug. 1, the upper series of anthers had still closed cells. At 12 noon, of this day, five unexpanded flowers with long exserted styles were examined. In three axes the anthers of the short stamens had shriveled without ejecting pollen—in one, two were pollen-bearing, while four had shriveled—in the remaining one, the whole six were abundantly polliniferous.

The mass of wild plants is not extensive, but it furnished a good bunch of specimens with long-styled flowers, and another bunch with styles exserted only half the length of the calyx tube. None with the very short styles figured by Mr. Darwin were growing in this mass. It occurred to me to note the relative fertility of the long and medium styled plants. Of the shorter styled, one branchlet had seed vessels from 55 axils, with from 4–6 seed vessels in each axil, and four others, 45, 48, 45 and 66, respectively. Of the longer styled 57, 35, 45 and 44.

So far as comparative fertility is concerned there is no material difference between the two classes.

It is clear to my mind that the flowers in these two classes do not furnish each one its own pollen, nor do they receive much aid from diurnal insects. Possibly nocturnal ones may assist, but if so, no moth hair is visible on the stigmas, as there should be. As the styles remain without withering for some days, showing that they have not received pollen, the great probability is that the pollen is in some way scattered from the upper flowers on the stigmas which continue in a vital condition long enough to profit by it. Strong vegetative vigor prevents seeding in the lower parts of the stronger branches, even though the flowers were fertilized.

STRUCTURE OF FLORETS IN BIDENS BIPINNATA.

Watching closely, on August 28, the anthesis of *Bidens bipinnata*, precisely the same phenomena were observed as is recorded of *Heliopsis lævis.* The style pushes up the staminal tube, starting at night-fall. During the next day the pollen is pressed through the divisions of the incurved staminal appendages, the style branches protrude the following nightfall, the staminal tube retires the next day, followed the following day by the retreating style.

In the arrangement of the floral parts there seems more definiteness than in many Compositæ. Normally there are five outer "involucral bracts" with foliaceous scales,—and these spread, some time before the rest of the flowers open. But sometimes only three of this verticil spread, in which case the other two remain erect and are not distinguishable from the inner series of involucral scales. Cutting away these five carefully we find no sign of an axillary bud at the base of these bracts. Then we have another series of five (seven in appearance, where the two lower bracts have become "scales"), at the base of these five we find axillary buds. By examining a number of heads, it is soon seen that these axillary buds develop to florets. The buds develop equally in the axis of each scale,when they rest, apparently for about a day, and growth is resumed, when, strange to say, one leads off in rapidity of growth, outstripping the rest. Occasionally another will nearly equal it, but two at least exhibit a very puny growth. These form the ligulate rays, and in consequence of the irregularity noticed, there are often only two fully formed ray florets, the others remaining beneath the outer series of scales in an independent state. Inside of this series, another series of five scales appear, the axillary buds of which develop to fully formed disc florets. The next series of five, however, seldom all perfect,—usually only two.

Taking the theoretical structure of the flower to be on the plan of five, we look for indications of this numeral in the ovarium. I have, however, never found traces of five awns. Four are usually present; but one or two so weak that unless searched for, two only might be supposed present. The weakest is at the base of the scale and the next weakest opposite. The two stronger are in the lateral positions fronting the scales, and give eventually the bidentate character to the akene. At times there are only three teeth. We may probably assume, in the theoretical conception of the floret, that five "involucral scales" primarily formed the calyx which becoming adnate with the ovarium formed the akene, but that one of these became wholly absorbed before the final growth of the structure. The scales are the dilated bases of leaves, and the awns abortive petioles or laminæ. When but two awns remain, it is simply the result of the total or partial suppression of three of the original members of the five-leaved verticil.

RHYTHMIC GROWTH IN FLOWERS OF HELIOPSIS LÆVIS.

It must be well known to observers that the column of stamens in many Compositæ is drawn up far beyond the mouth of the floret by the advancing pistil, and that subsequently it descends, and is included in the floret. I believe I am the only one who has called particular attention to this behavior in Compositæ, though others before me have noted a shrinking tendency in the filaments of some Chicoraceæ, which has been attributed to an irritable habit. Noting in a large mass of *Heliopsis lævis* growing near my house in Germantown that the elevation and depression of the staminal column occurred at stated hours during the day, I started on the 16th of August to devote observations several times a day for a week to an examination of the behavior of the flowers.

The first observation was that of the hundreds of flower-heads that had flowered during the summer season, not a floret could be found infertile. This with me is indicative of self-fertilization. But I believe it is conceded by all biologists who have given attention to this large order of plants, Compositæ, comprising a tenth part of the vegetable kingdom, that the florets are mostly self-fertilizers. Where there is a tendency to diœcism, and where there are ray florets pistilliferous only, these—the very small minority—must, of course, have florets requiring aid in pollination from other flowers. The most that has been claimed for Compositæ is that they are "adapted to cross-fertilization;" but even this statement is derived from a theoretical conception of the plant's behavior, for every practical test made by excluding insects has found the florets just as fertile as if insects had been allowed free access to them. It was, however, well worth while to keep this topic in view while making my notes. The date of the observations is given, as I have a suspicion that the phases of growth are not identical in different seasons or localities, though the uniformity goes on with tolerable regularity.

The lobes of the corolla expand soon after daylight, resting at once when open. But the style continues to lengthen. The appendages to the stamens, similar in form to the lobes of the corolla, bend over, and completely cover the apex of the style, forming a cap like the apex of the finger of a glove. Pressing against this cap the whole column is carried upward by the style growth. At length the filaments will stretch no more—the style still advances—the pollen is brushed upward by the plumose stigmas, and at length the appendages of the anthers are forced apart, and through the crevices the pollen is thrust. Pollen gathering insects have a rich field throughout the day, collecting the material thus forced to the top of the staminal tube. By sunset the stigmas appear, covered by pollen ; and it is interesting to note, by examination of a floret at this stage, how nearly clean the pollen has been brushed out by the upward movement of the style. At sunset the pollen-covered style commences to expand, and, curving over, seems to aid in pressing back the column of stamens to the interior of the floret. It was clear to my mind that the withdrawal of the staminal column was not wholly due to elasticity of the filaments or it would go down rapidly on the egress of the style which had raised it. But to make the matter more certain, I slit the column, so that it might be entirely free of any help from the style, but this did not add to the descent. The filaments are as long as the tube when the latter has attained its greatest elevation ; but when examined in the morning after the above observation, when wholly withdrawn into the tube of the floret, they had drawn down to but one-fourth the length. The lowering is due, not to irritability nor to elasticity, but the shrinkage common to all maturing structures.

Pollen grains were of course more numerous on the dorsal side of the style branches, but there was abundance for all fertilizing purposes on the stigmatic surfaces. At any rate, as the expansion commences at sunset and continues throughout the night, any fertilization which insects might aid would be due to nocturnal insects and not honey bees or others which have hitherto received the credit, simply because they were pollen gatherers from the unopened florets.

The morning following the expansion of the style branches, the style itself follows the stamens, and by nightfall of the second day the style has wholly withdrawn into the corolla. During this day the flower is visited by bees and other insects for nectar, but the shriveling of the style shows that fertilization had been accomplished during the night, and that the furnishing of the honeyed sweets to the insect visitors was a purely gratuitous act, for which the plant seemingly receives no compensation.

The style is bulbous at the base. The style on withering disarticulates at the apex of the bulb which remains as part of the seed vessel. Morphologically the bulb may represent an arrested node of growth, and it would not be surprising in some monstrous forms to find appendages develop from it or closely related genera, with some form of structure in which some organs developed from a position such as the bulb occupies.

The strongly adhesive power of the gelatinous pollen is indicated by the difficulty the style branches have in separating. The lower portion spreads while inside the staminal tube; but the apex still remains in contact, so that after the style branches have become quite clear of the tube, the branches, still together at the apex, form a diamond-shaped termination to the style. If a lance separates the mass of pollen, and thus liberates the apices, the style branches fly back with considerable force.

The style branches, after being drawn down into the corolla tube, were still of the same proportionate length with the undivided portion of the style, as when fully expanded: again showing that the withdrawal was not due to any irritating or contracting power at the base, but to a uniform shriveling in all its parts. These advances of the different parts of flowers and rests while others advance, are extremely interesting. It is now twenty-three years since I recorded similar behavior in the flowers of the compass plant, *Silphium laciniatum*,[1] and I regret that neither I nor others have followed far in the path of observation there marked out.

FLOCCOSE LEAVES OF ANTENNARIA PLANTAGINIFOLIA.

In the midst of a large quantity of *Antennaria plantaginifolia* in Mount Desert Island, Me., while numbers had the leaves green on the upper surface, many plants were so densely floccose that no green could be seen. The deprivation of the light was complete, and I could form no conception as to how the green could be equally dense beneath this thick growth of wood, as in the leaves exposed. The text-books say " leaves silky-woolly when young, at length green above." But the woolly plants seem woolly to the last, while the green-surfaced leaves seem on wholly different plants. The latter has undulate, and occasionally crenate serrate, leaves; and the leaves are minutely dotted in places where hair should have grown.

---

[1] Proceedings of the Academy of Natural Sciences, 1870, p. 117.

ENDURANCE OF PORTULACA OLERACEA.

In early autumn light white frosts occur, the tenderer plants being injured in patches. Blackened leaves occur at intervals, and considerable areas will have escaped, though of the same species as those injured. This erratic character of an early light frost is usually referred to atmospheric currents, the atmosphere being a trifle higher or lower according as injury or escape from injury may result. This is probably the case, though no absolute tests by self registering thermometers have been made to my knowledge.

After one of these early frosts, the past October, I noted that a large area covered with *Portulaca oleracea,* the common Purslane, had a large number blackened by frost, while possibly an equal number were unharmed. I was about passing over the fact under the explanation already noted, when I observed that in many instances healthy plants and plants blackened by frost would be found together, their branches interlacing. In every case of the kind examined, not a single leaf would be injured in the one case, while in the other case the whole plant would be destroyed. The destruction in these cases could not have been by any variation in the intensity of the cold wave, but must have been from a less power of resistance in the plant itself.

The facts detailed furnish valuable lessons and suggestions. May not the varying effects of a first "white frost" be as often from varying powers of resistance as from varying intensities of the cold wave?

Again it is frequent to have increased hardiness, as well as many other characteristics, referred to the effects of environment. As the plants here, and their ancestors for many generations, must have been under like conditions, the unequal results can scarcely be attributed to environment, but to the elasticity of character possessed by the whole organized world. In *Portulaca oleracea* we may safely say some plants are hardier than others; yet over the whole northern world where it is found, the plants are yet totally destroyed by a comparatively light frost. Ages of existence under severe climatic conditions have not rendered it, on the whole, hardier than when it first ventured on its hyperborean march,—for the great home of the family is undoubtedly sub-tropical. The seeds of this and other plants with a similar home, are frost-proof. They will live in the ground, under any degree of frost. Hence sub-tropical plants that can perfect their seeds before frost arrives, can travel very far northward. It is to this power and not to any change of original character by environment that the northward march of these plants has been due.

EARLY FERTILIZATION OF SCUTELLARIA GALERICULATA.

Wishing to study the teleology of the crest or pouch on the calyx lobe of *Scutellaria*, a large number of specimens of *S. galericulata* in various stages of growth were collected at Seal Harbor, Me., on July 13. No additional light could be thrown on the purpose of this curious process, but some facts not generally known in relation to the behavior of the flower during anthesis were noted as being worth recording.

Of all authors at the command of the writer, Bromfield[1] is the only one that notes in this species that " the stamens as well as the style included, and lodged with it in the oblong inflated convexity or crown of the upper lip." I had noticed that every flower was fertile, and from this inferred self-fertilization. The style is never longer than the stamens, and the anthers and upper portion of the style are bound together in their " lodging." The anthers burst their sacs simultaneously with the expansion of the flower, and cover the whole upper portion of the style with pollen. Portions of the corolla fold so tightly over the upper portions of stamens and style that no insect can reach them. Even when an attempt is made to press open this portion of the corolla with a light twig, the expansion is unwillingly performed.

A remarkable circumstance is that the flower falls soon after full expansion, carrying the style with it, thus showing that full fertilization of the ovarium had already taken place. It is probable that the pollen grains are active much earlier in the unopened flower, than seemed to be the case from my few hours of observation.

FERTILIZATION OF TRIFOLIUM PRATENSE.

At my own residence, Philadelphia, I have never been able to notice humble-bees entering Red Clover by the mouth of the corolla,

---

[1] *Flora Vectensis*, p. 383.

—all that I have seen visiting the flowers perforate the tube. It was interesting to note at Seal Harbor, that the species comparatively abundant on July 13, always entered by the mouth. I could find no flowers with the corolla tube perforated. It was interesting further to note that though there were cases of light colored flowers, the prevailing tint was of a much brighter rose than clover fields further south present.